

able that in selecting a commentator and literary executor the choice should fall on one who possessed the power of removing what was obscure in the theory and of placing the scheme in the most advantageous light. Admiral de Horsey has nothing to recommend him for the office he has undertaken but an unstinted admiration for the original author and a loyal desire to secure his recognition as a profound thinker. We respect and admire the sincerity of his conviction and his resolute effort to uphold the reputation of his departed friend. The struggle he has made is pathetic, but we regret to say he has only succeeded in darkening the issue.

General Drayson was dissatisfied with the theory of precession. He could not accept the explanation of the change of coordinates as due to the revolution of the earth's pole about that of the ecliptic, while at the same time the obliquity of the ecliptic was continually varying. He did not admit that the circular motion was a close approximation to the truth, and that greater accuracy was obtained by making the radius of the circle vary. Yet the device is a very usual one in the explanation of a recondite subject. It is often found that a broad general truth requires a minute degree of qualification. "The geometrical absurdity of a circle with a movable centre" seems to have presented a difficulty that the gallant General never mastered, and he therefore devised another plan for computing precession. Owing to the slow motion of the earth's pole, there is no difficulty in contriving an arithmetical process, by which the results when confined to a limited number of years shall be similar to those obtained by the ordinary formula. General Drayson's plan was to make the earth's axis revolve in a circle of radius $29^{\circ} 25' 47''$, about a point 6° from the pole of the ecliptic, and situated near the solstitial colure. The annual motion of the point marking the origin of longitude (apparently not precisely coincident with the first point of Aries) is $40.89''$, consequently the cycle of precession is about one-quarter longer than that assigned by astronomers.

Admiral de Horsey's contribution in support of his friend's theory has been to compute the precession of many stars by this method, and to compare the results with the Nautical Almanac values. The agreement is satisfactory, but if this proved anything one would think it proved the Nautical Almanac correct; but that view does not commend itself to the Admiral. Partly perhaps because in Drayson's method the obliquity of the ecliptic will vary in the course of a cycle between 23° and 35° , and thereby the glacial theory, provided that geologists could be satisfied with so short a period as 15,000 years, might be satisfactorily accounted for. The author also claims that some difficulties he imagines to exist in the reckoning of time can be removed by this means of explaining precession. He is not, however, very fortunate when he puts the late Mr. Stone in the witness-box to prove an anomaly in time reckoning. This may be a small matter, but when the author confuses precession with aberration we feel that, with the best intentions of serving the interests of his lost friend, he is scarcely fitted for the task.

THE MEASUREMENT OF ILLUMINATION.

Illumination; its Distribution and Measurement. By A. P. Trotter. Pp. xvii+292. (London: Macmillan and Co., Ltd., 1911.) Price 8s. 6d. net.

DEDICATED to Pierre Bouguer, the father of photometry, this book is the first really scientific attempt to put illuminating engineering on a proper basis, and is the outcome of the work which has been done in America and England of late years to break away from the haphazard methods of lighting which have so long been in vogue, and to replace them by arrangements of the sources of light which shall lead to a satisfactory distribution of light over the area to be illuminated.

No one more fitted to undertake this work than Mr. A. P. Trotter could have been found, and the experience he has gained since 1879, when he worked out his dioptric system of uniform distribution of light, has enabled him to produce a book which will prove invaluable to those who realise that the mere statement of the candle-power of a light offers no guide to its lighting effect, and that fifteen candles burning in different parts of a room give a very different illumination from one fifteen candle gas-jet burning in the chandelier.

The book very wisely is confined to the methods of distribution and measurement of illumination, and the portions dealing with photometry are more especially amplified in this direction, whilst all descriptions of systems of lighting have very properly been omitted.

The first chapter deals with the units and standards of candle-power, from the much-abused candle to the impracticable Violle melted platinum unit, but surely Mr. Trotter is a little unjust to the former when he says "the so-called English Parliamentary candle of spermaceti was not more scientific and hardly more accurate than the barleycorn of which three went to the inch." There are many photometricians of the old school who could assure him that the sperm standard candle, as made by Miller, when its use was guided by common-sense rather than by departmental directions, fell short of the modern standard in little else than convenience.

In the second chapter the author discusses "illumination and derived units," and it is pleasant to find due credit given to Sir William Preece, who, as early as 1889, recognised the necessity for a measure of illumination, and adopted the carcel-metre, to which unit he gave the name "lux," a name afterwards applied by the Geneva Congress in 1896 to the bougie-metre. The latter part of the chapter is devoted to a clear enunciation of the laws of light, flux of light, brightness, quantity, and reflection.

The distribution of illumination, more especially over a plane, occupies the next two chapters, and in the fifth photometers received full attention, and this chapter is of special value, as Mr. Trotter has introduced into it so much of his own work. It would have been even more interesting if he had criticised the various photometers from the point of view of the personal equation, as many observers would have liked to know his opinion of the Referees' table photo-

meter as compared with the open-bar disc photometer for general gas-testing work.

Several chapters are devoted to the minutiae of photometric work, whilst in chapter ix. the measurement of illumination is dealt with, and another chapter describes the practical application of the methods employed, the work concluding with a valuable review of the subject of dioptric distribution of light.

The whole work is excellent from all points of view, and will form an addition to the engineer's and architect's library of far more than ordinary value.

MODERN GEOGRAPHY.

(1) *The Nations of the Modern World: an Elementary Study in Geography.* By H. J. Mackinder. Pp. xvi+319. (London: G. Philip and Son, Ltd.; Liverpool: Philip, Son, and Nephew, Ltd., n.d.) Price 2s.

(2) *A Geography of Ireland.* By O. J. R. Howarth. Pp. 224. (Oxford: Clarendon Press, 1911.) Price 2s. 6d.

(3) *Aberdeenshire.* By A. Mackie. Pp. x+198.

(4) *Huntingdonshire.* By the Rev. W. M. Noble. Pp. ix+152.

(5) *Worcestershire.* By L. J. Wills. Pp. ix+154. (Cambridge: University Press, 1911.) Price 1s. 6d. each.

(1) **T**HE first of these works must not be regarded merely as a reading book for schools. It is, as its author observes, "a book of mingled geography and history," and contains so much matter that it was surely worthy of an index. While it develops the theme of three previous works, and brings out the bearing on human relations of the geographical conditions there described, it forms at the same time an independent treatise, which will stimulate the memory of many readers of full age. It is these, indeed, who will enjoy it thoroughly. A knowledge of modern history, and much of it obtained at first hand, is necessary for the complete appreciation of the changes of the map of Europe. Mr. Mackinder brings the older stages, such as those accompanying the Seven Years' War and the Napoleonic epoch, tersely and vividly before us. The later steps, the freeing of Venice, the partition of Lorraine, the uplifting of Bosnia, belong to our own eventful times. But we are led also to trace the rise of the United States and of Japan, and to take a large and scientific view of the inevitable expansion of Germany (p. 250), where men almost of our own blood are looking out also on the world. It may be somewhat ironic to suppose (p. 257) that the immense progress of Egypt under British organisation incited the Turks to improve their own home government; but the author's treatment of the British Empire as a whole forces a sense of responsibility upon the most insular and reluctant conscience. We may not like the reference nowadays (p. 258) to Japan and Turkey as "two heathen Powers," a phrase that has slipped in somehow from Mr. Mackinder's studies of the early nineteenth century; but his outlook is elsewhere that of the philosophic traveller. Under his direct and closely written sentences, we

trace always that fine feeling for duty which is man's highest possession on this strange rotating globe.

(2) Mr. Howarth's "Ireland" is a welcome addition to the Oxford Geographies, a series edited by Prof. Herbertson. Aided by maps and excellent photographic illustrations, it brings the features of the country, grouped in natural regions, well before us. The author makes somewhat little (pp. 44 and 45) of Jukes's classic explanation of the courses of the southern Irish rivers, and seems to think that the Blackwater may have run against the face of an up-raised fault-block at Cappoquin. Lamplugh's justly accepted explanation of the Scalp is neglected on p. 64, while the gorge of the Dargle is strangely described as having been deserted by its stream. Fig. 5, showing a drumlin-covered country backed by the Curlew Hills, is not so representative as it should be of "the Central Lowland," and the geological descriptions generally seem to date from the appearance of Hull's "Physical Geology and Geography of Ireland." We thus have Archæan granites (Fig. 3) opposed to large areas of "Cambrian and Silurian" strata in the metamorphosed regions; but the author himself must be held responsible for the insertion on his map of a Silurian district in the extreme south. Chapter xxvi. might be improved by an account of the cooperative organisation of agriculture, which has been largely aided by the fact that Ireland is a convenient and detached geographical unit. The publications of the Irish Department of Agriculture will assist Mr. Howarth in his next edition. The book has so many good points, and so clearly connects the structure of the country with the life of its inhabitants, that we hope it will meet with ready recognition.

(3) The county geographies issued by the Cambridge University Press, with their coloured physical and geological maps, and numerous landscape illustrations, have already taken a high rank. *Aberdeenshire* is largely a granite county, with solemn ice-worn highlands, and castles as stern as the jutting rocks along its coast. Mr. Mackie is a student of nature with a keen literary taste, and human interests and antiquities are evidently as attractive to him as are the birch-woods and the moors.

(4) The Rev. W. M. Noble's "Huntingdonshire" in the same series presents a very different country, where the fundamental rocks rarely appear from beneath the covering of glacial detritus and alluvial fenland. Too little emphasis seems to be laid (p. 31) on the high interest of the boulder-clay. The agricultural features, the great manor houses, and the stone bridges along the grand old highways are excellently illustrated and described.

(5) In "Worcestershire," Mr. L. J. Wills has a fascinating field. He describes the high ridge of Archæan granite in the Malverns, which rise on the western border like a blue wave against the evening sky. He illustrates the British formations up to the oolites of Bredon, and then directs attention to the upland vegetation of the Lickey Hills and the relics of old forests in the lowlands. The frosts in the hollows of the fruit-growing districts (p. 45) are, we presume, due to the creep of cold air downwards on still nights.